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Presenting Evolution in Public Schools; Is It indisputable?

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by

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Chapter 1

Introduction

More unexplainable questions continue to arise about human origins and our universe that the theory of evolution cannot answer. Questions like: Where did all the matter come from? How did organic matter form from non-organic matter? Aren't our bodies irreducibly complex? Why have scientists never observed an increase in genetic information? Doesn't information require a sender or intelligent source? If the formation of life and the development of new kinds of organisms forming from other organisms are considered statistically improbable or impossible, why does it seem public school Biology and Life Science teachers are teaching the theory of evolution as fact? Unexplained questions like the ones listed above have led me to my capstone question, how do 10 public school teachers present the theory of evolution?

Having gone through public schools and universities myself, and having been a paraprofessional and a teacher in public schools, I have not seen any alternatives taught as it pertains to origins and evolution. The language used in textbooks and lesson plans have led me to believe that public school Biology and Life Science teachers are teaching a theory as fact and indisputable when it comes to evolution and origins. With so many pending and unexplainable questions currently existing (which are vital to establishing the theory as fact or law), why are no alternatives taught, and why are textbooks using language that assumes indisputable?

Definitions

It is important to understand the definitions from which I am referring. I will use *A Student's Dictionary & Gazateer* (2012) to define the terms "theory" and "fact" for

which I will refer to going forward. *A Student's Dictionary & Gazeteer* defines theory this way: "theory, noun, an abstract plan, an hypothesis" (p. 326). It also defines fact as: "fact, noun, an indisputable piece of information, a certainty" (p.122). From these definitions I conclude that the theory of evolution is one possible hypothetical ("hypothesis") explanation of origins. It is therefore not indisputable simply because it can be disputed simply based on the remaining unanswered questions and evidence which are vital in showing observable proof.

The Beginning of My Interest

My interest in this topic started many years ago and began to flourish after my brother, who is a mechanical engineer, told me about a book by Michael Behe, *Darwin's Black Box* (2003). After reading further from a variety of different sources about the theory of evolution and all its problematic issues, I began to wonder why I was never taught this information in high school and college. Professionals with advanced degrees (most with PhDs) in different scientific arenas all point out unexplainable flaws and non-provable assumptions made to make the theory of evolution work. I am still in wonder about how so many credible scientists such as Dr. J.C. Sanford (2008) who point out all the complications with the theory of evolution seem to go unnoticed by educators and schools concerning what is being taught about evolution. This was the beginning of my journey that led me to what I am researching today. Are public schools intending to teach the theory of evolution as indisputable scientific truth?

As a young person I remember learning about evolution and millions and billions of years. Most of the young people I talk with today seem to accept it as factual, and many of the people my age and older that I talk with either accept "the science" on

evolution or are unsure about it. In most cases, they usually cannot point out any problems with the theory.

I remember being taught that over time in human evolution people gave up some advantages of walking on all fours to walking upright in exchange for developing a larger and more intelligent brain. In those years I didn't question this too much. As I think back on the concepts I've seen taught in schools about evolution I ask, how do they know that? How do they know thousands or millions of years ago the reasons for walking upright or increasing brain size? These are all assumptions. The more I read or was taught about evolution the more I saw the assumptions. This led me down a path of more questions. I kept asking, how do you know? It seems to me that evolutionists, on one hand, are trying to say we're still putting together the pieces but we know it's true. That is like saying we have not finished the puzzle, in fact we have not even connected any small clusters of puzzle pieces, but we know how it all goes together.

For many years I always knew that we all have a world view (the foundations from which we interpret information), point of view, or perspective. In previous philosophy classes I remember several discussions about this. I am sure none of us like to be questioned or challenged to some extent, or to have people argue with you just to argue. However, it was particularly biology teachers and professors I found got irritated when I or another person asked challenging questions, especially when it came to teaching what they assumed as indisputable about evolution.

Professional Background

As a paraprofessional I spent many hours with students in life science, biology, physical science, and Earth science classes. When students were learning about origins

or evolution, it was always taught as indisputable, no alternatives were given. Sometimes I would ask the teachers (in private) if they ever read a book like *Darwin's Black Box* by Behe. The response was always "no," "never heard of it." Periodically a teacher would refer to evolution as the "theory" of evolution but the language that was used in the textbooks and instruction was always as a matter of fact. More strangely to me was most teachers could rarely tell me about any assumptions or unexplainable problems with the theory of evolution. It seemed to me that middle and high school teachers were only instructed in or allowed to teach the so-called "facts of evolution."

When I was substitute teaching, I sat in many staff lounges and overheard and even participated in conversations where teachers sometimes shared their unfiltered thoughts. I did my best to be a bystander and just listen to the conversations. However, sometimes I couldn't resist the temptation to interject my point of view. For example, one common phrase I would hear teachers use was "truth is relative." This is a contradiction in just three words. They are making an absolute statement about relativity. I often would just ask this to my co-workers: Are you absolutely certain truth is relative? Most of the time they got my point. The same were the conversations with teachers when they shared their opinions about evolution. When I would ask them a question to explain how they knew a particular idea was true or what the observable evidence was, for example, dinosaurs evolving into birds, they usually said they don't have any observable evidence yet (like transitional fossils) but it was only a matter of time until they found the evidence. We need the observable evidence before we can conclude something is true.

After several years of evolution popping up in discussions, I decided to read more about it. I also started thinking more about what our children are being taught, and as far

as I can tell there is no alternative taught in public schools as it relates to life on Earth. This absence in alternatives seems to mean teaching evolution as fact. Never have I heard any explanation from these sources about where all the matter came from, or how they knew that for a fact. Many times when they did try to explain they often had to make many assumptions using language like, if this happened then this may be possible.

There is one final point to make based on my own observations about differing viewpoints about evolution and origins. Most of the articles and books I have read by evolutionary scientists make common mistakes. First, they assume that the theory of evolution is a “neutral” unbiased position to take when researching the origins of life and our universe. Second, evolutionary scientists almost always lump creation scientists, intelligent design scientists, and other alternative view points as one and the same. The theory of evolution and the worldviews of evolutionary scientists are not neutral. Evolution is the attempt at explaining origins using random chance processes. Nature is all there is. It is an attempt at explaining life and our universe without the "supernatural" or "God." It is from this worldview or starting point from which evolutionary scientists examine the evidence.

Chapter Summary

As I learn more on the topic I find multiple resources that should make all teachers and the education system rethink what is being taught about evolution. Many resources are available that point out major problems with the theory of evolution which are not taught in any class I have attended in public schools or universities. Things like irreducible complexity, problems with radiometric dating methods, and recent discoveries of pliable soft tissue and fluids in dinosaur bones. At minimum, I believe public school

biology and life science teachers should teach the challenges and problems with the theory of evolution, not just the parts that try to prove evolutionary models? If scientists cannot say with absolute certainty that evolution is indisputable, then shouldn't we openly discuss the problems with the theory as well?

The main purpose of my study is to identify in what context does the set of interviewed public school teachers teaching biology, life science, and related subjects, teach the theory of evolution? In chapter two I intend to model the scientific method to show why scientist, teachers, administrators, researchers, etc., need to reconsider how we teach the theory of evolution and why it needs to remain a theory (in the context of a possible explanation) and not taught as indisputable truth.

Chapter two will be the literature review which will include resources discussing this topic. In chapter three I will discuss how I will conduct the research. Chapter four will be the actual testing of the research through interviewing ten public school teachers teaching biology, life science, and related subjects and analyzing the data collected. In chapter five I will report my findings and draw my conclusions which I suspect will show public schools are teaching the theory of evolution as indisputable science and teach no alternatives with respects to life on Earth. The final step will come with the completion of my capstone to report my results.

Chapter 2

Literature Review

As I will show in this chapter, there are differences in opinions among scientists with respects to evolution. The literature review will frame the context for my research question, how do 10 public school teachers present the theory of evolution? This chapter discusses the following topics: the importance of the scientific method when discussing evolution, understanding Historical and Observational Science, reasons given for teaching evolution, problems with the theory of evolution, and why teachers and scientists need to remain open-minded about the context in which they teach evolution.

Importance of the Scientific Method When Discussing Evolution

The first thing to understand is the scientific method. Scientists use this method to prove and verify their research. There are 7 steps to the Scientific Method:

1. Make an observation or state the problem
2. Conduct research and gather information
3. Form a Hypothesis
4. Test the Hypothesis
5. Record and analyze the data
6. Report findings and draw a conclusion
7. Report results or replicate

The Scientific Method is a way for scientists to repeat and test results to show whether something behaves in a consistent fashion. If inconsistencies or contradictions are found scientists may repeat and test again and again until they discover the

discrepancies. If they cannot discover the reasons for the inconsistencies they may need to start over and re-evaluate the problem or observation.

It is my intention to use the scientific method with this study.

1. I have made an observation - It seems public schools are teaching the theory of evolution as scientific fact.

2. In this chapter (chapter two) I will present research and information that point out flaws, inconsistencies, contradictions, and unprovable assumptions that shows evolution is not a proven fact.

3. In chapter three I will discuss how I will conduct the research.

4. Chapter four will be the actual testing of the research through interviewing public school teachers teaching biology, life science, and related subjects and analyzing the data collected.

5. In chapter five I will report my findings and draw my conclusions which I suspect will show public schools are teaching the theory of evolution as scientific fact and teach no alternatives with respects to origins.

The final step to the scientific method will come with the completion of my capstone to report my results.

Understanding Historical and Observational Science

A person's presuppositions do make a difference when trying to do science. Ultimately, there is no such thing as completely neutral. The starting point from which people interpret the evidence can vary from one person to the next, and can ultimately be the reason for why two people, with the same facts, studying the same evidence, can come up with two very different conclusions.

Some people think proving or disproving evolution is a matter of who has the most facts to support their side. Some scientists may assert the counter argument is seeking different answers or results. We are not each collecting our own facts and evidences but share the same facts and evidences, however it is how we interpret that data which leads us to the conclusions we come to, which can cause us to ignore other facts that cause difficulty with a theory, interpretation, worldview, and collection of data in totality.

For example: the assumption is if an animal only had sharp teeth it must have been a carnivore, if it has both sharp and molar teeth it is an omnivore, or if it only has dull molar like teeth it is primarily a plant eater. Fossils are often compared with animals today to support a theory. However, we can use observational science here in the present to show the assumptions. Grizzly bears only have sharp teeth yet 80% of their diet is made up of grasses, fruits, and shrubs. There are monkeys that only have sharp teeth yet they are entirely vegetarian.

This leads me to the differences between Historical and Observational Science. Patterson describes the differences between the two. Patterson describes Operational (Observational) Science as "a systematic approach to understanding that uses observable, testable, repeatable, and falsifiable experimentation to understand how nature commonly behaves" (2007, para. 13). The language hear is extremely important when it comes to science and the scientific method. For something to be considered fact or a law of science, we must be able to observe what is being tested. It must be testable and not assumption based. If we repeat the test the result should remain consistent and not based on false pretenses. This is the type of science that allows us to understand how rockets work, how DNA codes for proteins in your cells. It helps doctors and scientists find cures for diseases.

Patterson goes on to describe Historical (Origins) Science as: "interpreting evidence from past events based on a presupposed philosophical point of view" (2007, para. 16). Since we cannot directly observe, test, or repeat the past we must interpret the past. Our presuppositions will affect our interpretations. Patterson goes on to talk about that neither evolution nor creation can be tested and repeated because we cannot repeat the past. Both creation and evolution are based on assumptions of how the Earth and our universe began. Evolution assumes there is no God and the universe and all that is in it was formed from natural processes. Biblical creation assumes there is a God who created everything. The point Patterson is trying to make is, the argument is not over the evidence, it is over the way we interpret the evidence. The starting point from an evolutionary point of view is very different from that of a biblical creationist. The

explanations of the history of our universe end up very different based on which worldview you start with.

Reasons Given for Teaching Evolution

The Minnesota Department of Education sent me the Minnesota science standards and *Evolution and Minnesota's 2009 Science Standards Talking Points*. The *Talking Points* discuss why Minnesota public schools have included science standards on evolution, and not including other topics discussing origins. The Standards Revision Committee uses different resources for writing the standards. One of the sources they cite suggests that policy makers do not require the teaching of any alternatives to evolution or "arguments against evolution" (2009). The article concludes with "The Committee recognized that the concept of evolution rests on a firm base of evidence, and that the basic understanding of this evidence is learned by students over a long period of time. Hence, the substrand Evolution of Living Systems has standards that start in first grade" (2009). This means that the concepts of evolution are woven throughout each student's entire public school education.

Dr. Petto wrote an article *Why Teach Evolution* for the NCSE (National Center for Science Education). Petto begins with describing what biological evolution is and the differences between macroevolution and microevolution. When discussing why evolution is mandated in science standards he gives 2 main reasons: "First, it is the fundamental, unifying theory that underlies all the life sciences" (para. 4). Second, "science education standards emphasize learning the process of science and especially scientific inquiry" (para. 5). He goes on to describe that the theory is what guides research and that it is not simply a guess. One of the most interesting comments by Dr.

Petto was "evolution begins after life is established on Earth" (para. 2). He claims that evolution is not about the theory of origins or how life began. Petto suggests the theories of origins are "religious ideas" (para. 8). Petto explains that one of the major reasons evolution is included in standards is because it is "recognized by the scientific community as settled because of its consistent performance in supporting research for some time" (para. 7), and that evolution "has overcome all scientific challenges" (para. 9). It would be interesting to hear Dr. Petto's responses to the challenges below by scientists with their own expertise in the biological sciences.

Eugenie Scott wrote an article discussing what public school science teachers can and cannot teach as it pertains to evolution. Scott says, "teachers and scientists say, teach evolution (para. 2)." She suggests that if students are not learning about evolution they are not receiving a proper education. She quotes the 1st Amendment of the US Constitution and comments that "schools can neither promote nor inhibit religious expressions. So it is perfectly legal for a teacher to teach about religion, although it has to be in a nondevotional context" (para. 5). Which means teachers can talk about and describe a religion or religious view, but they cannot say anything promoting it like saying it is right. Scott provides several federal court cases where they rule in favor of teaching evolution only. Scott cited cases like, Epperson v Arkansas (para. 7), Peloza v Capistrano (para. 9), McLean v Arkansas (para. 10), and Webster v Lennox (para. 14). In the end, Scott argues that legally teachers are required to teach evolution in the science classroom and as the standards require. As for religious views teachers can only talk about what religious views are but cannot promote or advocate for them.

In the article, *Evolution Is a Theory… and That Is Saying a Lot* (Lorentzen, 2009), the author is trying to make the point that because the majority of scientists agree evolution is true or scientists believe there is evidence to support evolution, this makes it just as good as facts and as close to the "truth" as you can get. According to Lorentzen, as long as the majority agrees, that is what will prevail. Majority rules.

Problems with the Theory of Evolution

In *Genetic Entropy & The Mystery of the Genome*, Dr. J. C. Sanford (2008) uses the term "Primary Axiom" to describe biological evolution: "Life is life because random mutations at the molecular level are filtered through a reproductive sieve acting on the level of the whole organism (p. 5). Sanford says, there is a standard answer given when asked, where did all the biological and genetic information in the genome come from, and how can it be maintained? The answer typically given is that "mutations" and "selection" have created all of the biological information. He goes on to say that Neo-Darwinian Theory says that "all genomes (instruction manuals) must have derived from a simple initial genome via a long series of mutations (typographical errors) and lots of natural selection (differential copying)" (p.4-5). An axiom is an idea that is not testable and accepted by faith because it seems so obviously true by many reasonable people. Sanford argues that biological evolution is considered an absolute truth by most evolutionary scientists based on this. Dr. Sanford challenges others to question whether or not they should accept the Primary Axiom, and what if the Primary Axiom can be shown to be wrong. Sanford has the reader look at the genome as a whole, and argues that the human genome is deteriorating and always has been. This is the opposite of what is needed for progressive evolution to show an increase of genetic information. Sanford, a geneticist

himself, gives several examples of how we misunderstand increases in genetic information. How mutations do not actually add information. At best it modulates the information that is already there. He also describes how deleterious and harmful mutations vastly outweigh any beneficial mutations always resulting in a net loss of information resulting in a deteriorating genome. Sanford wrote, “While I will enthusiastically agree that selection can shape some specific gene frequencies, I am going to argue that no form of selection can maintain (let alone create!) higher genomes” (p. 63). Sanford’s main position in his book is to show that “mutations, even when coupled with selection, cannot generally create new information” (p. 27).

Dr. John F. Ashton (2012) discusses how there is no evidence or explanation from evolution scientists about how life or organic material can form from inorganic matter. Ashton goes on to say, "A single cell is vastly more complicated than anything human minds have ever engineered" (p. 40). Ashton talks about the vast systems within a single cell are so advanced, complicated, and dependent on other functions of the cell that each of its functions couldn't have arisen without the other. The jump from inorganic matter to organic matter is impossible. Even if one or more proteins did form by random chance processes it is equally improbable that they put themselves in the right order to create a function. One example Ashton provides is the process in forming a cell. One step in this process is the removal of water to form the needed biopolymers. From an evolutionary point of view with early life arising out of water this would be extremely difficult if not impossible. This isn't the only problem. The biopolymers would also have been assembled in just the right sequence. "This process is important because the sequence (that is, the particular order) of these building blocks actually encodes the information

that directs the chemical reactions responsible for the cell's existence" (p. 41). Ashton describes how hundreds of reactions with the right concentrations along with other parts of the cell must already be in place so that the reactions would go just the right way for life to begin.

Scientists have never been able to successfully replicate any life generation in the laboratory either (Ashton, 2012). It has never been shown that life can be created from non-life. In fact it has never been observed that new genetic information has been created in nature or a laboratory whether through natural selection or mutations. Natural selection and mutations are thought to be the driving force behind evolution. In fact, through these methods we have only observed a loss of genetic information (Ashton, 2012).

Irreducible complexity is another problem with the theory of evolution. Although we can observe small variations within a species through natural selection those variations already exist within a functioning system. How does evolution explain how the system got started or came into existence. For a system to work (for example, a single cell) all the parts need to already exist and be in the right order. Behe (1996) explains this as it pertains to Biochemistry. Behe quotes Darwin's writing, "If it could be demonstrated that any complex organ existed which could not possibly have been formed by numerous, successive, slight modifications, my theory would absolutely break down" (p. 39). What type of biological system is this? Behe answers, "a system that is irreducibly complex" (p. 39). To explain the basic function of the simplest organisms or the basic system within a more complex organism it is the cell. Behe illustrates this by using a diagram of a simple mousetrap. Just like any animal or plant cell, for that cell to function it must have certain proteins and other cell parts and structures already in place

and in the right order for it to function. A mousetrap must also have certain parts to operate and put together in the right order. The most basic mousetrap must have a platform, hammer, spring, sensitive catch and holding bar as well as staples to hold those objects in place. Behe states, "in determining if a system is irreducibly complex is to ask if all the components are required for the function." (p. 42). If any one of these basic parts to the mousetrap are missing or in the wrong place the trap will no longer function. The cell is the same way. If any of its basic functions are missing or in the wrong place it will no longer function. Several books and articles I have read by professional scientists' state that irreducible complexity is good evidence for intelligent design because all of the basic functions must be in place for an organism to exist and for natural selection to have anything to work from.

Not only are basic biological systems irreducibly complex, evolutionist must also account for how information came into being. Lisle uses the words in his book as an example of information. Just like words in a book "DNA also contains information" (p. 18). Certain theorems must apply when we find information. Lisle (2009) describes two of these theorems:

> 1. There is no known law of nature, no known process, and no known sequence of events that can cause information to originate by itself in matter.
> 2. When its progress along the chain of transmission events is traced backward, every piece of information leads to a mental source, the mind of the sender. (pp. 18-19)

The first theorem tells us matter cannot spontaneously generate information. The second tells us that only a mind can generate new information. Just like any book you

read, we all understand that it was written or generated by the mind of its sender. No one would claim a book was a bunch of random chance processes of mistakes and typos using random letters. DNA is no different. DNA is information. The information must be put together in a precise sequence in order to bring about life. Not only does it need to be put in the right order but it also needs to have a mechanism to read the code. Just like reading a book, the reader must understand the letters used and know what sounds they make when put together otherwise it is meaningless. DNA must contain the right combination of amino acids and proteins, and a mechanism to read the information. This could not have come about over long periods of time as evolution explains simply because if any one of these parts or mechanisms were missing DNA would be useless. The laws of information science show that DNA (life) could not have come about by random chance processes. "Creative information cannot spontaneously increase by chance. It is always the result of intelligence" (p. 20).

In some circumstances mutations do have survival value however it is not relevant as "mutations have never been observed to add brand-new information, and thus they cannot be the driving mechanism of evolution" (Lisle, 2009, p. 19). For example, the bacteria that cause ulcers: can become resistant to antibiotics, but it is not because it has evolved into something new or has gained information. The opposite is true. The antibiotic that attacks the bacteria causes a protein in the bacteria to turn into a poison and thus kills the bacteria. It has been observed that when the bacteria replicates itself in some cases it does not pass on the gene or protein the antibiotic uses to turn that particular protein into a poison to kill it, thus it becomes resistant to the antibiotic. This is not

because it evolved into something more complex. It actually has become less complex. The bacteria has no new genetic information, and in actuality has become less complex.

DeYoung (2006) is questioning our recent conventional accepted age of the Earth. DeYoung questions the most common dating methods, their inconsistencies, and many assumptions they use to determine dates. DeYoung also shows other evidence of younger ages with radiometric dating processes. A few points of interest in his book as it relates to this topic are dating assumptions and finding Carbon 14 when we shouldn't.

To start, I think it is important to point out the differences between carbon dating and other radioisotope dating methods. Most people have heard of carbon dating as a way to date objects with carbon, however I wonder if most people understand that the carbon dating method can only be used to date things that are more recent (within 100,000 years). What separates carbon dating versus other radioisotope dating is its relatively short half-life "5730 years" (p. 46). After about 100,000 years Carbon 14 is undetectable. Other radiometric dating methods have longer half-lives which can presumably date older objects.

There are three major assumptions we make when using radiometric dating processes. The first is "the initial conditions of the sample are known accurately" (p. 42). In other words, we assume how much of the parent and daughter elements are known when the sample formed. The second assumption is whether there has been any contamination in the samples life. We can't be certain if any of the elements have leaked in or out of the sample during its life. The third assumption is whether the decay rate, or half-life, has remained constant since the object was formed. When we use different dating methods to date rocks, for example, we often find different ages, sometimes vastly

different ages. That's because of the assumptions we need to make. With these types of assumptions we cannot be sure of the accuracy of the dating methods.

Because of carbon dating short half-life we find many examples from all around the world of finding Carbon 14 in samples where it should not exist. For example, we find Carbon 14 in things like coal, natural gas, diamonds, and dinosaur fossils. We presume the ages of these examples are millions or billions of years old, and we know Carbon 14 is undetectable after about 100,000 years, yet we still find Carbon 14 in these samples. If these samples are truly millions or billions of years old we shouldn't find any Carbon 14. If radiometric dating methods are accurate then using Carbon 14 Dating shows us the Earth, or at least these samples, are much younger than we thought. If these dating methods are not accurate, then we cannot use them as an accurate dating methods. At minimum, it puts these dating methods into question.

Why Teachers and Scientists Need to Remain Open-minded

Hoernschemeyer (2000) discusses teaching the scientific method is more than just teaching a step by step process. It is about teaching students critical thinking skills. This includes using these skills in all subjects. This article is primarily about why we teach the scientific method, the importance of integrity, and its usefulness across all subjects. What I found most interesting about this article was the open mindedness of the author. The author encourages openness to opposing ideas. "There are no sacred truths or forbidden questions" (2000, para. 14). Hoernschemeyer talks about how we must continually look for possible errors. "Controversy is not avoided; it is embraced as a challenge for better facts and stronger theories" (2000, para. 60). The author also discusses the importance of understanding and how we all want to prove we are right, but

we really test ourselves if we can disprove our theories. Now, I have no idea what this author's views are on the subject of evolution, but his enthusiasm of how we should be teaching subject matter and critical thinking is of most value to this study. If public school teachers teaching biology, life science and other related subjects are only teaching one possibility to the subject of origins are we not by default teaching the theory of evolution as fact? If we are not scrutinizing for possible errors, are we teaching critical thinking?

Chapter Summary

As we can see there is a difference in opinion among scientists about the accuracy of evolution. Both sides are very passionate about their research. It is interesting to discover the point of views the participants in this study have towards this subject. Though Interviews I should be able to get a flavor for how do 10 public school teachers present the theory of evolution? Chapter three will discuss the methods I will use to interview participants and gather this information.

Chapter 3

Methods

This chapter discusses the methods I used will to collect data to answer my research question. How do 10 public school teachers teach the theory of evolution? This chapter describes the participants. It also describes why and how I collected and documented the data. Through interviews I was able to sample how 10 public school teachers teach the theory of evolution. This chapter includes sections on participants and settings, data collection, approval to conduct the study and informed consent.

Participants and Settings

The participants for this research were public school teachers who teach biology, life science, or related subjects that includes evolution methods. I chose two elementary school teachers whose schools introduce Life Sciences. The remaining participants were middle and high school teachers. My goal was to interview ten participants. My intent was to interview teachers in at least three different public school districts.

To encourage as many participants as possible I left the place for the interview to be determined by the participants. I traveled to their choice of location. I tried to encourage a more professional setting such as the school they teach at or public library in attempts to avoid distractions and to help the participants feel more comfortable and give as candid answers as possible (Creswell, 2003, p.181).

Data Collection

I conducted in-person interviews. The advantages for interviewing participants in-person are “participants can provide historical information” and “allows the researcher

control over the line of questioning." (Creswell, 2003, p. 186) A limitation with an interview may be that my "presence may bias responses." (Creswell, 2003, p. 186)

To gather information about how 10 public school teachers teach the theory of evolution, I conducted qualitative interviews. The first part of the interviews were open-ended questions their students may ask. These questions were intended to obtain responses on how they would answer a student. The second set of interview questions were responding to me, another adult. These interview questions were related to parts of evolutionary theory to determine how participants are presenting the information, their explanations for why they teach what they teach, and to determine if participants have considered whether the information they are teaching is fact or theory. Comparing these two parts helped determine how 10 public school teachers teach the theory of evolution.

Now, answers vary from teacher to teacher, and how participants interpret questions vary, this is why I decided to create a qualitative methods interview. The first few questions were likely scenario questions students might ask their teacher. These questions were intended to get information about how a teacher may respond when asked a question about origins. The teacher was free to answer in a qualitative way with no prompting answers to choose from.

The following questions were given three possible context answers with a chance to respond in a qualitative manner, clarify, and/or ask follow-up questions. Each of these questions had prerequisite answers in the fashion of true/false, yes/no, or fact/theory that participants will be asked to respond to as a starting point for any in-depth explanations. Responses to prerequisite answers helped minimize misinterpretations of more elaborate

responses by participants and were used for this purpose only. Each question was given the possibility of "not sure."

Based on the nature of some questions and answers, I asked for examples, to please explain, or how they know. Asking follow-up questions helped encourage teachers to give more qualitative responses rather than simply answering yes or no. All responses of "not sure" were followed up with please explain why you are not sure. I allowed the interviewees the opportunity to elaborate on their answers as it provided an explanation or perspective this study had not taken into consideration.

The interviews were audio recorded as a way for me to refer back to exactly how a participant responded. Notes were also taken in case of audio equipment failure. (Creswell, 2003, p. 190) Responses to each question will be transcribed as direct quotes and paraphrases.

Since there seems to be confusion and disagreement by some as to the definition of the term "evolution," I made a clarifying statement before the interview was conducted. The clarifying statement was as follows: for this interview, when referring to evolution, I am referring to molecules to man, or one kind of organism changing to another kind type of evolution. It is not referring to Natural Selection or what some call microevolution (or minor changes or variations within a kind).

Approval to Conduct the Study and Informed Consent

My request to conduct research was approved by the Hamline University School of Education Human Subjects Committee. Anonymity is very important for this study. To ensure participants' privacy, their names and the names of their schools will have pseudonyms, and that no information that could identify them was used. Interviewees

will be called Participant [Number].Their school districts will be referred to as Public School District [Letter].

Making sure they understand this before the interview may help participants feel more comfortable giving honest and more candid answers they might not otherwise give if they thought something could come back to them. All participants signed consent letters.

Chapter Summary

This was a qualitative study using interviews. The participants were given the opportunity to answer open-ended questions with the possibility for follow up questions. Complete anonymity is very important to this study and no identifying details were given. All the participants were asked the same 13 questions. Chapter four will report the result of this study by showing how participants answered each of the questions.

Chapter Four

Results

Teaching the theory of evolution is part of the Minnesota state standards, and therefore required for all public-school curriculums. The curriculum gradually introduces the concepts of evolution over several grade levels and is studied at greater depths at the middle- and high-school Life Science and Biology courses. Given that evolution is a required part of public school curriculum, and considering in some cases it is in conflict with other people's research, understanding, or beliefs about evolution, this can be a controversial topic. The controversy about evolution led me to the capstone question: How do ten public school teachers teach the theory of evolution? This chapter analyzes the results of my data collection in this chapter.

Background

There were ten participants in this study representing three different school districts. Two participants were elementary teachers, two participants were middle school teachers, and six participants were high school teachers. Six participants were women, and 4 were men. All ten were asked the standard set of 13 interview questions. The interview questions I asked are listed here:

1. When a student asks how life began, what do you tell them? Why? How do you know?
2. When a student asks, "Did life Evolve", what do you tell them? Why? How do you know?
3. If a student asks you how old our universe and/or Earth are, what do you tell them? Why? How do you know?

4. Do you teach the difference between Historical Science and Observational Science?
5. Do you teach evolution as fact or theory?
6. Do you teach any concepts that pose problems with the theory of evolution?
7. Do you teach any alternatives or other scientific theories other than evolution that may explains the origins of our universe and life on our planet?
8. Do your school officials and/or policy allow you to teach anything other than evolution when instructing students on the origins and life on Earth?
9. Have parents raised any concerns with you pertaining to evolution or origins?
10. What materials are being used in your classroom? Do these materials present evolution as fact or theory?
11. Are you expected to teach your students that the theory of evolution is fact?
12. Do you think the theory of evolution should be taught within the context that it is a theory (a possible explanation of origins) or fact (similar to a proven law of science)?
13. Should public schools allow alternative explanations other than evolution to be taught about origins?

The interviews were audio recorded and then transcribed. I also took written notes as I interviewed the participants. The transcribed interviews will not be included in the appendix to maintain confidentiality. For analysis purposes, I divided their responses into three categories: Participant responses to possible scenarios questions 1-3, and 9), how participants teach evolution, and participants views about alternatives to evolution.

Participant Responses to Possible Scenarios (Questions 1-3, and 9)

Question 1: When a student asks how life began, what do you tell them? Why? How do you know? Participants 7 and 10 said no one knows for sure how the first life began. Participant 3 stated, "I would start with the creation of atoms and molecules, we can't say God did it. I would use words like, what most scientists believe." Participant 1 made the distinction about what the scientific community says and what religious groups like "Judeo-Christians" believe. Six participants gave potential evolutionary explanations for how life possibly began such as the Big Bang, the right combination of atoms, simple bacteria and differentiation, biomolecules coming together in a pool, chemical evolution, and biological evolution.

The second interview question asked was: When a student asks, did life Evolve, what do you tell them? Why? How do you know? 8 out of 10 participants (1, 2, 4, 5, 6, 7, 8, and 10) answered without hesitation, "yes." Participant 9 answered "I wouldn't say life has evolved I would say the diversity of living things has increased through evolution. Asking whether life has evolved is over simplifying the process. We started out with a simple single celled organism and now we have the great diversity of life we see around us. Getting from point A to B has been the story of evolution." Participant 3 stated, during class time they would tell the student what scientists believe about evolution and the beginning of life, however, the same participant also stated if asked outside the classroom on their personal time what they believed she would tell them she doesn't believe we evolved from one species to another.

For question three I asked: If a student asks you how old our universe and/or Earth are, what do you tell them? Why? How do you know? The majority of responses

were relatively similar. Participant 3 tells students, "Scientifically the earth is about 4.6 billion or so years old. She added, however some have doubts about whether that is accurate". The other nine participants stated they would tell students, "billions of years", and 7 participants (3, 4, 6, 7, 8, 9, and 10) were more specific saying "4.6 billion" for the Earth, and "14 billion" for the universe. Participant 1 quoted Carl Sagan "its billions and billions of years old."

I also included question nine in this section as it pertains to potential and actual scenarios. The question asks: Have parents raised any concerns with you pertaining to evolution or origins? 6 of 10 participants (1, 2, 3, 4, 5, and 8) said they have not had any parents raise any concerns with them about what is being taught pertaining to evolution or origins? Participant 1 said, "a student has but not a parent." Participants 3 and 4 said not with them but colleagues have. Four participants said they have talked with concerned parents. Participant 6 said that one "was a family that that took a literal interpretation of Genesis." Participant 7 said, "not in a long time, 15-20 years." Participants 9 and 10 said they have but not a lot.

How Participants Teach Evolution

Question four asked:

> Do you teach the difference between Historical Science and Observational Science? As a reminder, let me give you the definition again from chapter two. Patterson describes Observational Science as "a systematic approach to understanding that uses observable, testable, repeatable, and falsifiable experimentation to understand how nature commonly behaves" (2007, para. 13).

> He goes on to describe Historical Science as "interpreting evidence from past events based on a presupposed philosophical point of view" (2007, para. 16).

Four of 10 participants (1, 2, 5, and 8) said they do not or distinguish between the two. Participant 5 said, "It's probably all historical." Three of 10 participants (3, 4, and 7) said they do a little. Participant 4 said, "I think I could do more with historical science." Participant 3 stated, "We do a fossil lab where we try to interpret the evidence." Three of 10 participants (6, 9, and 10) stated they do teach the difference.

The fifth question asked each participant: Do you teach evolution as fact or theory? Several participants had issues with this question. Most of the participants prefaced their answers with describing the difference between "scientific theory" and "facts." In chapter one I used *A Students' Dictionary* (2012) to define the words fact and theory as follows" "Theory, noun, an abstract plan, a hypothesis" (p. 326) and "Fact, noun, an indisputable piece of information, a certainty" (p. 122).

Here are descriptions of four participants that show it is important to describe the distinctions they were trying to make. Participant 9 described the difference this way:

> Theory is an explanation of a broad based phenomenon that is supported by observational science and evidence both now and in the past and encompasses other facts laws and other theories. With Evolution it is the foundational theory of biology.

He also described fact as "a fact is an explanation of something that was observed to occur given the parameters of that observation." Participant 10 described theory as "meaning well grounded, not going to changes much, basis of biology, lots of evidence to prove it." Participant 8 compared the theory of evolution equivalent to "germ theory, cell

theory, and gravitational theory." Participant 3 describes evolution simply as "change over time."

Now, nine of the ten participants prefaced their response to this question with something similar to above. With that understanding, these nine participants said they taught it as theory. Participant 2 said at the elementary level "I don't teach it at all. We talk mostly about adaptations and natural selection."

Participant 9 noted, "No I don't call it fact but it is as close to a proven thing as science is comfortable to getting and science will not say something is 100% proven." After interviewing the participants, it seems that nine of the ten participants would agree with this statement.

For question six I asked, "Do you teach any concepts that pose problems with the theory of evolution?" Nine of 10 participants said they do not teach any concepts that pose problems with the theory of evolution. Participant 9 said, "we teach some of them but most of it is misunderstanding." Meaning that most challenges the theory of evolution are students who simply misunderstand those concepts.

The tenth question I asked the participants had two parts: "What materials are being used in your classroom? Do these materials present evolution as fact or theory?" Participants 1 and 2 use National Geographic Curriculum. Participant 1 said it leans heavier towards fact. Participant 2 said, "they don't go either way." Participant 3 stated she uses *Science World* magazine, *Discover* magazine, on-line resources, and rarely uses textbooks. Participant 4 uses a lot of on-line resources and rarely uses textbooks, stating, "We have written our own curriculum." Participant 5 said she mostly uses on-line internet text for the topic of evolution. She said these materials present the information

as both theory and fact. Participant 6 uses on-line videos and some actual skeletons of different animals to look at their similarities. He said, "It is definitely presented as this is our best explanations for these observations." Participant 7 said he uses physical evidence, magazine articles, and *Scientific American*. Participant 8 uses a textbook, resources from Berkley, the PBS series, and other video clips. Examples of the last are "What Darwin Didn't Know," "Walking with Beasts," and videos on whale evolution. Participant 9 uses a textbook, articles from other mainstream sources, and journal articles. When asked if the material presents evolution as fact or theory, he responded by saying, "Those sources we use operate with the scientific framework that the theory of evolution is the way biology operates. The question is settled from a scientific standpoint." Participant 10 uses videos like "The Shape of Life Series," Nova programs, and PBS. She uses textbooks and some outside reading. She stated, "Labs are a little bit hard to do. We might compare some DNA strands that are close to each other in labs."

Question eleven asked, "Are you expected to teach your students that the theory of evolution is fact? " Participants 5, 6, and 7 said yes. Participant 6 stated, "that is the expectation of me." Participant 7 stated, "theories are factual as we know them." Three of 10 participants (1, 2, and 3) said no. Participant 3 said as "long as they are teaching the standards, and the standards don't specifically say we need to say it is fact." Participant 4 said she would need to refer to the standards, but does not think the standards even use the word "theory." Participants 8 and 10 said they are expected to teach it as a theory, with the caveat of defining a scientific theory and the supporting evidence is factual. Participant 9 told me neither: "We do that with everything that is a theory."

For question twelve, the second-to-last question, I asked each participant this: Do you think the theory of evolution should be taught within the context that it is a theory (a possible explanation of origins) or fact (similar to a proven law of science)? Six of 10 participants (1, 2, 4, 5, 8 and 10) all said taught as a theory. All the participants stated it is a strongly supported theory supported by facts. Participant 3 said theory because "it isn't really a proven fact." Participant 6 said more towards a proven law of science. Participant 7 responded, "the question is not valid. It's not about origins, it's about changes already existing." Participant 9 again said neither. He followed that response with saying there needs to be a new understanding of what the word theory means. Theory means something different in science. A theory is not a guess in science.

Participants' Views about Alternatives to Evolution

For question seven each, participant was asked, "Do you teach any alternatives or other scientific theories other than evolution that may explains the origins of our universe and life on our planet?" Seven of 10 Participants (1, 2, 6, 7, 8, 9, and 10) said they do not teach any alternatives or other scientific theories. Participant 3 said she has an enrichment class where students will sometimes bring up the Multi-level Universe Theory. She said she will spend some time discussing it with students if they bring it up. She added, "Because I teach in a public school I cannot teach creation otherwise I would get into trouble. Otherwise, I would if I could." Participant 4 said she will sometimes talk with students about what life is (could there be other forms of life) and if there is other life in the universe. Participant 5 said she will sometimes talk with students about how people bridge religion and evolution. She tells students the Catholic Church accepts evolution.

The eighth question was "Do your school officials and/or policy allow you to teach anything other than evolution when instructing students on the origins and life on Earth?" Three of 10 participants (2, 5, and 6) said they did not know for sure where their school officials or policy stood on the issue, but were interested in finding out. Seven of 10 participants (1, 3, 4, 7, 8, 9, and 10) said no, that they only teach the standards.

Question thirteen was the final question: Should public schools allow alternative explanations other than evolution to be taught about origins? Five of 10 participants (4, 6, 7, 8 and 9) said no. Participant 4 followed no with "in a science course the science is what should be presented. It's not an option it's the law." Participant 8 added, "I don't think science teachers should be teaching other methods that aren't included in the standards." Participant 9 added, "as soon as there is a scientifically acceptable alternative, but there is not." Participant 7 responded that we should neither encourage nor allow anything but evolution in structured education. Participant 10 tells her students "they need to look at biology as a whole and whatever has the strongest evidence and that is what they should teach and that is evolution. It's not a faith based curriculum it's an evidence based curriculum." Participant 2 said he was not sure. He thought it would be ok if we can include all cultural versions. Three of 10 participants (1, 3, and 5) said yes. Participant 1 said as long as everybody in the community is open and agrees to it. Participant 3 added, "Our job in education is to preparing kids for life outside of the school walls and they're going to be hearing about these other ones."

Chapter Summary

Even though there was some difference of opinion among participants with some of the questions, the common denominator for all ten participants was their agreement to

follow the Minnesota state standards. Nine of 10 participants present evolution to students as factual in the sense that it is without doubt evolution (less complex organisms evolved into more complex organisms) has and is happening. Only one participant teaches evolution in the context that most scientists believe evolution is the only explanation for the diversity of life. However that participant does not personally accept it, and would only express that view outside of school hours if asked.

Five of 10 participants were strongly against allowing any alternatives to evolution to be taught. Three of 10 participants said they were in favor of alternatives being taught. One participant was not sure, and one participant said only what the evidence supports should be taught.

Chapter Five

Conclusion

Prior to doing the research for this capstone, I was quite confident I knew what the results would be. Even though many of my predictions were confirmed, there were several concepts and ideas the participants provided I had not considered. In addition, I was also surprised by some responses in my quest to discover how 10 public school teachers present the theory of evolution. I believe this study will be most intriguing to parents of students who may have concerns about how the theory of evolution is being taught in science classes.

This chapter reports the conclusions I drew from these categories: participants' responses to possible scenarios, how participants teach evolution, and participants' views about alternatives. It also includes sections on limitations of project findings, recommendations for future research projects, final thoughts, and chapter summary.

Participants' Responses to Possible Scenarios (Questions 1-3, and 9)

For the first three questions, I asked the participants to respond as if a student was asking the question. The first question was "When a student asks how life began, what do you tell them? Why? How do you know?" 8 of 10 participants (2, 4, 5, 6, 7, 8, 9, and 10) responded to students that no one knows for sure how the first life began, and gave evolutionary examples of what some possibilities are. Participant 3 felt that she had to give an evolutionary example because she is not allowed to mention God. Participant 1 stated she gives them some evolutionary possibilities but also tells students there are people who have other religious beliefs of how life began.

From their responses, I learned that the majority of teachers interviewed, although admittedly not sure, were all very confident that life began by some evolutionary process. Only two participants even considered some other possibility.

The second question was "When asked did life evolve?" Nine of 10 participants said without hesitation that they would tell students yes. Participant 3 would tell students that some scientists believe we have evolved, but if asked outside of classroom time, she would tell them that she personally does not believe we have evolved. She said that there is evidence to support that as well. This is probably one of the most revealing questions to determine what participants' presuppositions are.

Even though this study can only speak to the responses of the ten participants, I can conclude that the majority of these participants believe evolution is a fact, in the sense that evolution has happened and is happening. I interviewed biology and life science teachers in three school districts. I wonder if this is similar to other teachers in other districts: That the majority science teachers are teaching the theory of evolution as factual and the only explanation for life on Earth.

If I were to do this study again, I am not sure I would ask question three, if a student asks you how old our universe and/or Earth are, what do you tell them? Why? How do you know? I am not sure it specifically helped answer my capstone question other than to show some possible differences in opinion for ages of the Earth. I would have taken out the part asking about the age of the universe as biologists and other life sciences deal mainly with just scientific events on Earth. All participants said they would tell their students the Earth is very old (billions of years). Participant 3 was the only participant to question whether that was accurate.

Question 9 shows that although a few students and parents have raised concerns about evolution being taught, it is not many. All of the concerns the participants mentioned were about how their students' families do not accept evolution because it is in conflict with their faith. This may indicate very few people have any issues with evolution. However, taking into account how many people have a faith background, and in my personal opinion (not supported by this study) I would expect that the number of people who take issue with the theory of evolution is higher than this study shows. Some families may choose not to bring their concerns to the teachers. On the same token there are also people of faith who don't have any issues with the theory of evolution or how it is taught in public schools.

How Participants Teach Evolution

In trying to determine whether teachers are trying to teach the theory of evolution as fact or theory, I was not using these two terms in the same context as the teachers do. In the literature review, I used *A Student's Dictionary* (2012) to define the terms "fact" and "theory. It defines the word theory as "a noun, an abstract plan, a hypothesis" (p. 326). It defines the word fact as a "noun, an indisputable piece of information, a certainty" (p. 122). One of my intentions was to discover whether or not public school biology and life science teachers are teaching evolution as a fact and indisputable that all complex life was derived from less complex life through processes of evolution, or whether they taught it similar to the definition above for theory, like a hypothesis or possible explanation.

This is also why before I asked each participant any questions I read them the following statement that I hoped would clarify any confusion about these concepts. The statement was as follows:

> For clarification: For this interview, "evolution" refers to molecules to man, or one kind of organism changing to another kind type of evolution. It is not referring to Natural Selection or what some call microevolution (or minor changes or variations within a kind).

Five participants took issue over how I stated each question using the terms fact and theory. The participants in this study do not use these terms in their science class the same way. After interviewing four participants I considered changing the questions slightly, but decided against doing that so I could stay consistent with what the participants were being asked and let each participant determine how to answer. I offered further explanation and clarification when I was asked.

Participant 2 was the only one who said he did not teach evolution, meaning his curriculum dealt only with adaptations and natural selection. Participant 4 said she teaches it as both fact and theory. She said there is a lot of evidence to support evolution; however there are gaps, and until proven 100% it needs to remain a theory. All the other participants said they teach evolution as a theory, with the understanding that there is no doubt evolution has happened and is happening, but since they do not have all the details, it remains a theory. All participants said they stick to the state standards when teaching evolution. 9 of 10 participants (1, 2, 4, 5, 6, 7, 8, 9, and 10) were very comfortable expressing that evolution, (meaning less complex life evolved into more complex life) is indisputable and teach it that way. Participant 8 said, "I wouldn't shy away from

evolution is happening in fact. Facts support evolution." Participant 3 was the only one who did not subscribe to the other nine participants' point of view. She teaches evolution within the context of the state standards and only expresses her opposing opinion outside of the classroom.

All except Participant 9 said they do not teach any evidence or concepts that pose problems with the theory of evolution. Participant 9 stated he does a little, and suggested it is not that the theory of evolution that has flaws. It is just that students misunderstand those concepts, and then offers them his explanations.

In this circumstance, teaching by omission is also teaching concepts and theories as fact or indisputable. Participant 8 put the theory of evolution on the same plain as "germ theory, cell theory, and gravitational theory."

The teaching materials these ten participants use asked about in question 10 also present the theory of evolution as indisputably happening, saying they are supported by facts, but keep it in the context of scientific theory only because they do not have all the exact details yet. All of the participants use videos, articles, and journals to demonstrate ideas and concepts and supplemental reading. Participants 1 and 2 use textbooks more heavily. Participants 3, 4, 5, 6, 7, 8, 9, 10 also use on-line resources. They do not rely as much on textbooks for their curriculum.

Even though there was contention for how I used the words fact and theory in the questions, what did come from the interviews was a clear understanding of how they teach the theory of evolution and their understanding of fact and theory. It can be determined 9 of 10 participants (1, 2, 4, 5, 6, 7, 8, 9, and 10) teach the theory of evolution in the context that evolution has and is happening and that evolution is factual. Nine

participants clarified that they know evolution has and is happening using facts and evidence. Participant 3 teaches evolution in this same way, but does not believe herself that there is enough evidence to say evolution is factual as far as simple organisms evolving into more complex organisms. An example is a single-cell organism eventually evolving into a dog. Participant 3 also was able to cite other scientific writings that point out many problems with the theory of evolution.

Participants' Views about Alternatives to Evolution

7 of 10 participants (1, 2, 6, 7, 8, 9, and 10) said they do not teach any alternatives to evolution. Participants 3 and 4 said they may spend some time discussing alternatives if the students brings it up. Participant 5 said if a student brings up the conflict of religion and evolution she will sometimes talk about how some people bridge religion and evolution.

All the participants feel they are expected to stick to the Minnesota state standards when teaching evolution. However, not all the participants agree that only evolution should be taught. Participants 1, 2, 3, and 5 were open to the idea of teaching alternatives to evolution. Participants 1 and 2 were in favor of alternatives to evolution being taught if everyone in the community is okay with it and if all points of views in the community are included. Participants 3 and 5 more eagerly said yes. Participant 3 added, "Our job in education is preparing kids for life outside of the school walls and they're going to be hearing about these other ones." 6 of 10 participants (4, 6, 7, 8, 9, and 10) were adamantly against teaching any alternatives. These participants responded that only science should be taught in the science classroom, inferring any alternatives to evolution is not science.

Through the entire interview did I bring up religion, and I did that intentionally. When I asked if participants knew of any alternatives to evolution, the overwhelming initial response was, "Do you mean religion?" I answered not necessarily. I sometimes got the feeling that some participants were implying that religion is void of any science. Participants 8 and 9 said sometimes students will bring up Panspermia (theory that life was seeded on Earth originated from somewhere else in the universe or by aliens). However, the conversations always looped back to science versus religion.

Through my research and from my perspective, evolutionary scientists and scientists who do not accept evolution as factual sometimes misunderstand one another. I will go a step further and say that it is predominantly the evolutionary scientists that maintain most of the misunderstanding. I am sure they would argue the opposite. However, scientists who don't accept evolution as indisputable, and referenced in chapter two of this study, like Dr. Behe, Dr. Ashton, and Dr. Sanford have PhDs in the biological sciences. Scientists can observe mutations with natural selection and it is testable, but scientists have never observed one kind evolving into another kind and therefore is not testable. Scientists can observe minor variations within a kind but we have never observed a whole new kind (dogs are still dogs). Not only that, but they point out many other problematic issues and assumption needed for evolution to be valid. It is clear that most participants in this study consider evolution (meaning simple life evolving to more complex life) and mutations with natural selection as basically the same thing. From this small study, it seems evolutionary scientists sometimes argue that scientists that do not accept evolution and people with a faith life simply deny science. I challenge all the participants in this study as well as all teachers to consider what Dr. Sanford (2008)

describes as the "Primary Axiom" is accurate.: "Life is life because random mutations at the molecular level are filtered through a reproductive sieve acting on the level of the whole organism (p. 5). Because the past is not repeatable and testable, ultimately they have to take it on faith that the "Primary Axiom" is true. This is the worldview evolutionary scientists have and the presuppositions they have to interpret evidence.

Limitations of Project Findings

One major limitation was time for each interviewed and for me. Most participants told me at the beginning of the interview how much time they had. Because of time constraints, I was not always able to engage participants with follow-up questions as I would have liked.

Another limitation was how to follow up with questions that did not seem like I was debating the participants. Because the purpose of this study is to gather information about how 10 public school teachers present the theory of evolution, it is difficult to ask them about opposing viewpoints.

A third limitation was the number of participants. Although ten participants is an adequate number for the scope of this study, with more participants and greater geographic distribution, I would have been able to present more data.

Recommendations for Future Research Projects

One of the first things I would focus on is reducing the number of primary questions and having more possible follow-up questions. I would focus more on the supposed facts, evidences, and testable observations of evolution, and ask more follow-up questions about whether they actually support evolution as indisputable. I would also use more language like accurate, indisputable, hypothesis, factual, without question, or

possible explanation, rather than fact or theory. As I found through this study these participants who teach about evolution do not use the terms fact and theory in their teaching in the same context other people may use them in everyday conversation. I found that the participants understood the word "theory" differently from the dictionary definition I used.

I would probably pick three to four primary questions that focus on three to four most important evolutionary topics. An example: How do scientists know that two different kinds of animals who share similar physical feature prove or show that they both have a common ancestor? This is a common argument used while doing labs in class comparing DNA charts or different fossils. The follow-up questions would focus more on asking for examples and responding to assumption-based responses. This is because some participants were adamant that any alternatives to evolution needed to be testable.

Research with these changes might shift the research question to wanting to discover if science content about evolution is assumption based or is testable and based on observable evidence. I would include arguments by science professionals that pose problems with evolution to see how interviewees respond to those disputes in the interview questions and literature review. Some evidence given by participants in this study often involved if-then possibilities. For example, the Miller-Urey Experiment was an example Participants 4, 5, 6, 7, 8, 9, and 10 used as a possible explanation for how life began. They said they show videos of this experiment. However, the experiment has since been debunked and shown to be filled with problems and is not possible in the development of life.

Final Thoughts

In addition to responding to interview questions, there were other side comments made while responding to the question at hand. I address a few of them, as I feel the nature of the comments justifies a response. The examples below provide context for how teachers present material on evolution and set the stage for teaching it.

The first is a comment by participant 8: "We definitely spend time talking about what a theory is. Germ theory, Cell theory, gravitational theory, people don't say, oh, you believe in gravitational theory"? I think the reason some people do not equate the theory of evolution on the same plain as these other theories is because germ theory, cell theory, and gravitational theory are all testable in the present. Determining if fish or amphibians evolved into dinosaurs is not testable in the present. I would say, we have fossil evidence, but we can only use interpretation with that kind of evidence. Our presuppositions can affect our interpretations.

When Participant 9 stated his definitions of fact and theory, he illustrated two examples he gives to his students. Here are his examples:

> For a long time the sun would rise and move across the sky, and it was a fact that it meant the sun revolved around the earth. Because that is the parameter about the observation. We did not have the means to observe otherwise. Along came telescopes and other ways to make observations and the facts changed. It is a fact that objects dropped on earth will fall a certain rate. But if you were to go to the moon or somehow change the mass of earth that fact would change. So it is dependent upon the parameters of the observation. It is changeable just like anything else.

I bring this up because I think these examples are deceptive and inaccurate themselves. Teachers can have incredible power and influence over students, and it is important for educators to be accurate, not deceptive or give inaccurate information. First of all, the stating that the sun rises in the East and sets in the West are the observational facts. The conclusion that the sun revolved around the Earth was inaccurate because the people of that time did not have all the facts. The parameters of the observations were incomplete. The facts did not change, people just discovered more facts and were able to draw more accurate conclusions. Providing inaccurate examples can deceptively influence students. Similarly, in his example for the acceleration of gravity on Earth compared to the moon, the facts did not change. The parameters of the test changed. The fact is that an object will always fall at the same on Earth and a different rate on the moon. One cannot compare the two because the test has been changed. I was not sure if this is intentional on his part, but I wondered if this sets up his terminology as inerrant.

Participant 9 told me how he starts out the discussion about evolution:

> Actually, that's how I start off my teaching of evolution. Even before the chemical evolution thing. I have what I call my house rules conversation. Where I say, ok how many of you have gone over to a friend's house and stayed the night, and say ok do you have a curfew, sure maybe it's 11:00pm, at your friends it's 10:00pm. If you are over at your friend's house who's curfew do you follow? They all say of course I would follow my friends. It would be rude to go there and say I'm going to follow my house rules. By the same token it is inappropriate and even rude for a science person to go into a church and say please prove to me that God exists because that's not how science operates. And I'm using the church and

> science thing because that is often the alternative explanation. It's inappropriate to the point of rudeness for a religious person to say we expect you to teach something that violates the rules of science. It needs to be testable and a higher power explanation is not testable in a scientific context. It doesn't meet the criteria for being invited.

My biggest issue with these comments is that this scenario insists students change their worldviews (their entire way of thinking) in his class to evolutionary presuppositions. They must accept what Dr. Sanford (2008) describes as the Primary Axiom: Faith that all life has evolved from a simple single-cell organism. I believe this also violates any possibility for other scientific evidence that contradicts evolution to be included in the conversation no matter how strong the evidence because the rules of the class are to discuss evolutionary process only.

Education should also be about critical thinking. To imply that a student is not welcome to bring other views to the table is to deny that. We cannot have critical thinking without being able to challenge the status quo. I agree teachers cannot spend all their class time discussing challenges, and there is a certain level of material every teachers must teach, but we cannot deny students the opportunity to be critical thinkers.

Chapter Summary

It is evident that all the participants teach the theory of evolution according to the Minnesota state standards. The majority of participants teach evolution is factual and indisputably has happened and is happening. All participants described the word "theory" in the context of scientific theory, and nine participants equate the theory of evolution on the same plane as cell theory, germ theory, and gravitationally theory. Only

one participant legitimately questions evolution as factual or undeniable. On the same token, Participant 3 teaches evolution according to the state standards and only gives her alternative point of view outside of the classroom.

As shown in questions one and two, all ten participants tell students humans have evolved, or at least tell students that most scientists believe humans have evolved.

Six participants felt including any alternatives to evolution was inappropriate for the science classroom. Two participants felt teaching alternative would be okay as long as everyone in the community agreed and included all views. Two other participants felt it was a good idea to teach alternatives.

This study will interest parents of students who may have concerns about how public school teachers present the theory of evolution. This study may also raise discussion about the appropriateness of allowing alternatives to the theory of evolution in the classroom. Future studies may consider diving deeper into discovering what facts and assumptions are needed for evolution to work and discovering scientific research that pose problems with the theory of evolution. It is my recommendation that the state of Minnesota review who is creating the state standards and whether that group of people are already strong supporters of the theory of evolution. Having only viewpoints of those who accept evolution as the only explanation and dismiss other research that poses problems with the theory will result in teaching evolution as indisputable truth, ignore other evidence, and leave legitimate questions unanswered. It is also my recommendation that those who create the standards for evolution be a panel of scientists that have a diversity of opinion about evolution, including scientists that question the accuracy, possibility, and probability of it.

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